

R25216a Digital Storage Oscilloscope

User's Manual

- *Digital Storage Oscilloscope*
- *Logic Analyzer*
- *FFT Spectrum*
- *Counter*

Revision

Software Win98/me/2000/xp Version



Rorixwell Inc.

Tel: 1 (416) 757 0764 Fax: 1 (416) 757 0764

10 Electro Road, Toronto, ON, M1R 2A7, Canada

E-mail: sales@Rorixwell.com

<http://wwwRorixwell.com>

Table Of Contents (R25216A)

Item Checklist.....	3
Installing Hardware.....	3
Installing Software	3
Guide To Operations.....	3
Feature	4
Main Screen.....	5
Horizontal Scroll Bar	5
Vertical Scroll Bar	5
Hardware Specifications	6
Clock Specification.....	6
Internal.....	6
External.....	7
Analog to Digital Skew	7
File Menu Commands.....	7
Auto Load Settings Command (File Menu).....	8
Settings File Format.....	8
Exit Command (File Menu)	8
View Menu Commands.....	8
Tool Bar (View Menu).....	9
Channel Display (View Menu)	9
Dots Connect (View Menu).....	9
Dots	9
Lines and Dots.....	9
Persistence Mode (View Menu).....	9
Setup Menu Commands	10
Calibration (Setup Menu).....	10
Probe Calibration	10
Logic Menu Commands.....	10
Trigger Word (Logic Menu)	11
Search Data (Logic Menu).....	11
Backup Menu.....	11

Channel Dialog Box	11
Probe	12
Coupling.....	12
Volts/Division	12
Offset	13
FFT (Window Menu).....	13
Measurements (Window menu)	14
Parameter Measurements	14
Accessories.....	15
Windows 98/ME USB driver install	15
Windows 2000 USB driver install	18
Windows XP USB driver install.....	21
Technical Support.....	24
Software Updates.....	24
APPENDIX.....	25
Fast Fourier Transformations	25
Introduction to FFT	25
Typical FFT of Applications.....	25
Fundamental Principles.....	25
Magnitude	26
Decibel (db)	26
Logarithm.....	26
The Characteristics of Weight Function	27
Functionality.....	28
FFT	28
Bw.Sweep	28
Source	28
Points.....	28
Window	28
Gain Type	29

Item Checklist

R25216A

- 1) The R25216A Aluminum unit.
- 2) Logic Pod X 1.
- 3) Probe (1:1, 10:1) HP-9100 X 2.
- 4) Color wires Harness and Easy Hook clips X 20.
- 5) USB cable (**1.5 M in Length**) X 1.
- 6) DC Power Adapter **12V/1A** X 1.
- 7) R25216A User's Manual X 1.
- 8) CD for R25216A driver X 1.

Installing Hardware

R25216A:

- 1) Connect the USB cable B type to DSO unit and A type to PC USB (Ver 1.1 or 2.0) port.
- 2) Plug in power source from +12V D/C Adapter.
- 3) Waiting for control software turn on.

Installing Software

- 1) Insert the distribution CD into drive E: ("E" is CD driver)
- 2) Select File menu.
- 3) Enter file to run E:\dso25216A\setup.exe.
- 4) Follow the on screen instructions.

Guide To Operations

When making measurements with the Digital Storage Oscilloscope / Logic Analyzer Cards, meaningful data can only be captured with some prior knowledge of the characteristics of the circuit under test.

Before initiating any capture cycles, the DSO must be configured using the control program. See the software section later in the manual for instructions on these procedures.

To connect the DSO to the test circuit, there are two standard BNC probes, one for each Analog input channel, and a series of mini-clips on the Logic Analyzer Pod for the Logic input channels. The scope probes have removable hook clips on their ends and an attached alligator clip for the signal ground connection. The Logic Analyzer Pod has inputs for 16 channels, D0 channel is the external clock input, and 4 ground points.

For synchronous data captures, external clock sources can be connected to the D0 channel. At times, it may also be necessary to connect the test circuit to the computer system itself.

This will eliminate more noise in the test application due to ground level differentials. This is especially true when dealing with high speed timing analysis. Use a heavy gauge wire to make a connection between the test circuit ground and the case of the computer.

Each Analog channel probe has a calibration adjustment. It is important that this calibration be made at least twice a year. See Calibration for more information.

when connecting the probes to any signal, make sure that the signal voltage is within the limits of the DSO. Check the technical information section for absolute maximum and recommended maximum input voltages for the probes.

Logic Analyzer Pod Markings:

D0-D15 Channel data inputs.
GND Signal ground connection.

Feature

- 1) Innovative cross triggering: logic analyzer channels can trigger the analog channels and vice versa.
 - 2) Long time pre-triggering up to 65534 x512 points, about equal to 33Mbyte storage.
 - 3) Fast screen update rates.
 - 4) Deep 128k sample data acquisition buffers on each channel.
 - 5) **Precision 100MHz Frequency counter, up to 7 digital resolution @128k memory for each analog channel.**
 - 6) **Advance Fast Fourier Transformations function to Bandwidth test.**
 - 7) **Convenient Timing state display for logic debug**
-

Main Screen



Horizontal Scroll Bar

This scroll bar is used in conjunction with a selected waveform or cursor. The Horizontal Scroll Bar will move a selected waveform or cursor left or right in the display area.

The Horizontal Scroll Bar works with Display, Analog input channels, Memory, Logic Analyzer channels, V1Bar, V2Bar, and Trigger Bar.

Vertical Scroll Bar

This scroll bar is used in conjunction with a selected waveform or cursor. The Vertical Scroll Bar will move a selected waveform or cursor up or down in the display area.

The Vertical Scroll Bar works with Display, Analog input channels, Memory, H1Bar, and H2Bar.

Hardware Specifications

Model	R25216A/128K [250MHz]	Remark
Resolution	8 Bit	
Sampling Rate	1Sa/s to 250MSa/s by 1, 2, 5 sequence	Internal clock
External Clock	1 KHz to 180 MHz	From Channel D0
Record Length	2K/8K/128K	Point
Analog Channel	A1, A2	2 Ch
Input Bandwidth	DC- 80MHz (-3db)	@BNC Connect
Input Impedance	1Mohm // 15pF	
Max. Input Voltage	50v (100v Transient)	@Probe 1:1
Sensitivity	5mv/div to 2v/div	
Trigger Level	Positive or Negative Slope adjustable level	10 Vertical Divisions
Spectrum FFT	80 MHz (Fast Fourier Transform)	
Electronics Counter	Max. 7 Digits resolution	
X - Y Plot	allow to graph one channel to another	
Math.	+, -, X, ÷	
Zoom	Zoom View Function	
Digital Channel	D0 - D15 (16ch)	Logic Pod
Input Bandwidth	DC - 100MHz	
Input Impedance	200Kohm // 3pF	
Max. Input Voltage	50v (100v Transient)	
Threshold Voltage	-1.8.v to +5.8v	by 50mv step
Trigger Qualify	0,1, x (don't care) settings for all digital channels	
Trigger Delay	32 Mega Length	
Operate	Hot Key / Mouse	
Power Supply	DC Adapter 12V/1A If sample rate under 100 MHz, No external power source require !	
PC Interface	USB (ver 1.1/2.0)	USB Only
Net Weight	1.4 Kgs	
Size	230mmx135mmx35mm	Aluminum Case
Accessories	Probe (1:1, 10:1) X 2, Logic pod. USB cable, Color wires with clips. User's Manual, CD driver.	

Clock Specification

Internal

Sampling Rate : 1 Sa/s to 250 MSa/s

Time base: 4ns / Division to 10Ks / Division displayable

External

Frequency: up to 200 MHz.

External Clock Delay: ~15ns.

Analog to Digital Skew

Analog channels are 5ns slower than Logic channels.

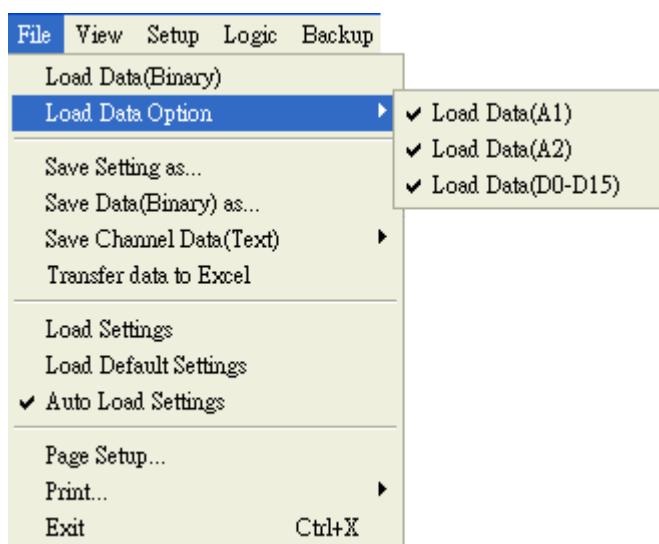
Setup/Hold Time : Internal Clock: 2/0 ns relative to clock edge.

External Clock: 2/0 ns relative to clock edge.

The memory mode will be displayed on the right side of the status bar.

Minimum required: a minimum of 64 Mbytes RAM is necessary to use the DSO control program.

File Menu Commands



The File menu offers the following:

Load data	This option loads a data file (.dso), with a setting file (.ini) together.
Load data option	This option select of A1, A2 or D0-D15 channel to be load.
Save setting	This option saves the current settings to a setting file (.ini).
Save data	This option saves a data file (.dso), every time saves all (A1,A2,D0...D15) data depend on Depth setting.
Transfer data to Excel	This option will convert data to Microsoft Excel by Decimal, Hexdecimal, Ascii or Unit(v).
Load setting	This option loads a previously Setting file (.ini).
Load Default Setting	Reset all parameters to factory defaults.
Auto Load settings	Auto load Dso25216.ini setting file on program start run to set all configuration.
Print Screen	This option allows you to print Screen (Hard copy).
Print FFT	This option allows you to print FFT Form.
Print Timing View	This option allows you to print Main Screen Form
Exit	Exit DSO software.

Auto Load Settings Command (File Menu)

Turns on or turns off the Autoload option. When this option is on, all settings will be loaded when start the program.

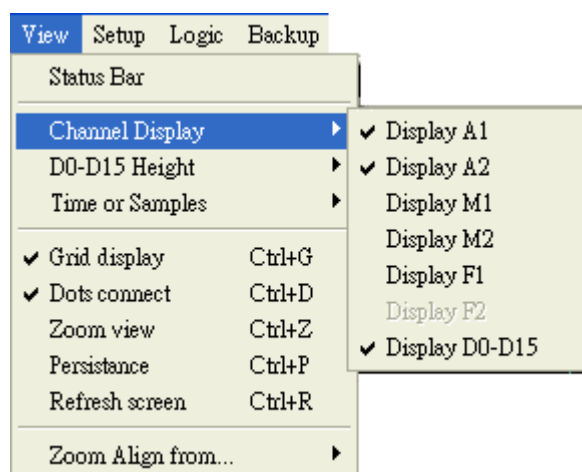
Settings File Format

The settings are now saved in an .INI file format and should be self explanatory.

Exit Command (File Menu)

Use this command to end your session. You can also use the Close command on the application Control menu.






View Menu Commands



The View menu offers the following:

Tool Bar	Show or hide Tool Bar.
Status Bar	Show or hide Status Bar.
Grid	Show or hide grid on analog display.
Channel display	Select display Channel(A1,A2,M1,M2,F1,D0-D15).
Dots connect	Displays analog data points and connections between data point.
Persistence	Data from previous captures remains on screen and is overlaid by new data.
Time or Samples	For Timing display, display Time like as 12.34ms, or display how many samples.
Search D15-D0 data	Search logic pattern forward or backward by V1bar or V2bar.
Zoom align from	Set cursor Bar(V1, V2, Trigger, Screen (left or center)) for zoom operate reference.

Tool Bar (View Menu)

- GO** The Go command tells the DSO to start acquiring data when the trigger conditions are satisfied.
 Pressed means Start capture, unpressed means stop capture.
 Moves one or more cursors to the display area. These commands are also available by clicking on the toolbar.
-  Moves Trigger Bar, V1Bar and V2Bar onto the waveform display area.
-  Centers waveform display area around V1Bar.
-  Centers waveform display area around V2Bar.
-  Centers waveform display area around the Trigger Bar.
-  Automatic setup parameters for capture.
-

Channel Display (View Menu)

When Display is checked, the channel will be displayed on the screen.
 When Display is not checked, the channel will not be displayed on the screen.
 Turning Display off for a channel will speed up the display. However the data is still acquired from that channel unless transfer is turned off.
 A channel's display can also be set with the buttons on the left edge of the screen.
 If the channel is on the button will be highlighted.
 You can also turn on/off transfer of the data for a channel.
 Note: This command applies to both analog and digital channels.

Dots Connect (View Menu)

Dots

Checking this option will display only the data points of the analog waveform. Logic data is unaffected by this option. This is the second fastest display option. Note that lines will always be shown when in Sin (X)/X or Filter Interpolation modes.

Lines and Dots

Checking this option will display the lines connecting the data points and the data points of the analog waveform. Logic data is unaffected by this option. This is the slowest display option.

Note: The lines and dots can be set to different colors.

Persistence Mode (View Menu)

Turns on or turns off Persistence Mode. In this mode, with each acquisition of data,

all previous waveform data remains on the display area. This mode is useful for finding waveform anomalies that occur infrequently. Persistence Mode is also useful for evaluating signal jitter.

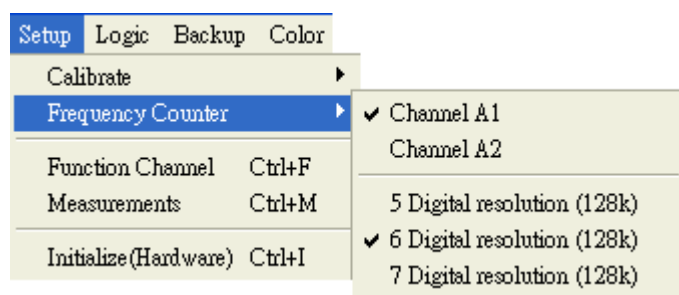
Scroll, zoom, change display width, or any update of the screen will erase all of the old data and will initiate a new Persistence Mode capture.

To turn Persistence On, select Persistence from the View Menu. To turn Persistence Off, select Persistence again from the View Menu.

Note: scroll, zoom, change display width, or any update of the screen will erase all of the old data.

See also: View menu, Toolbar, clear button

Setup Menu Commands



Calibrate

Calibrate the probe.

Trigger word

Set Trigger word for digital channel D0-D15.

Initialize (Hardware)

This option allows you to restart DSO.

Measurements

Setup Measure Item.

Calibration (Setup Menu)

Probe Calibration

- 1) Connect the scope probe Ground Connection to the BNC GND.
- 2) Hold the probe's tip against the calibration point on the BNC center Hole.
- 3) A Square wave signal should appear on the screen.
- 4) Adjust the probe calibration until a true square wave is shown on the screen, noting the corners of the waveform which should be sharp and square, not rounded over or peaky.

Logic Menu Commands

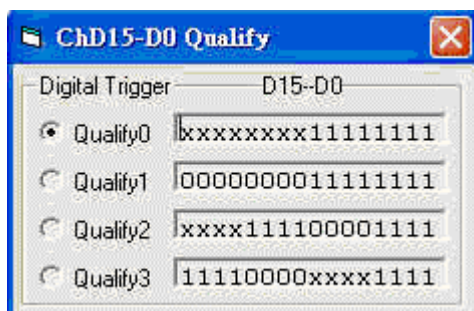
Trigger word

Set Trigger word for digital channel D0-D15.

Search D15-D0 data

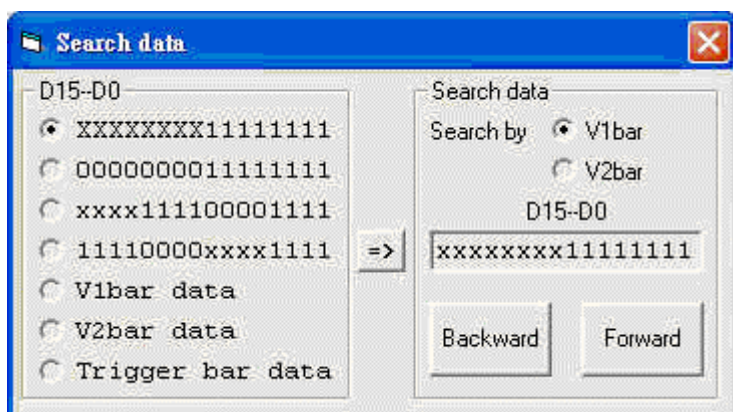
Search logic pattern forward or backward by V1bar or V2bar.

Trigger Word (Logic Menu)



The Trigger word backup four Qualify data for quickly set digital trigger.

Search Data (Logic Menu)



Backup Menu

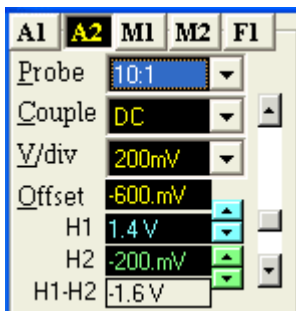
Backup Analog Channel to M1, M2 channel:

- Copy A1 to M1 Store channel A1 to M1(memory 1)
 - Copy A1 to M2 Store channel A1 to M2(memory 2)
 - Copy A2 to M1 Store channel A1 to M1(memory 1)
 - Copy A2 to M2 Store channel A1 to M2(memory 2)
-

Channel Dialog Box

Show the Channel Dialog Box. All channel parameters are displayed in this box and can be altered in it as well. You can bring up this dialog by clicking on the "Settings" button in

the parameter area for a particular channel or by using the channel pull down menus. A different channel can be selected by hitting the "A1,A2,M1,M2,F1" Ch Select button.



Probe

This controls the attenuation level for the probe inputs. This should be set to match the probe itself, either 1X, 10X, 100X or 1000X. When working with signal amplitudes within ?

0 V, either the 1X or the 10X setting can be used. However, if the signal amplitude is outside of ?0 V, use the 10X setting. Note that using the 10X setting with both the probe and the scope even for signals within ?0 V will provide better frequency response through the system due to smaller voltage swings through to the digitizer..

Voltage range Probe and probe settings:

5mv/div to 2v/div @probe 1:1

50mv/div to 20v/div @probe 10:1

500mv/div to 200v/div @probe 100:1

5v/div to 2000v/div @probe 1000:1

Coupling

The three selections available are AC, DC, and GND couple. Coupling can also be changed by Voice Command and the Channel dialog box.

In the AC setting, the signal for the selected channel is coupled capacitively, effectively blocking the DC components of the input signal and filtering out frequencies below 10 Hz. The input impedance is 1MW || 5pF.

In the DC setting, all signal frequency components of the signal for the selected channel, are allowed to pass through. The input impedance is 1 MW || 5pF.

In the GND setting, both the input and the A/D converter are connected to ground. Again, the input impedance is 1 MW || 5pF. Use for setting the Ground reference point on the display or if calibrating the DSO board.

Volts/Division

V/Div controls the vertical sensitivity factor in Volts/Division for the selected analog channel.

Each V/Div step follows in a 1-2-5 sequence. To get the best representation of the input signal, set V/Div such that the maximum amplitude swing is displayed on the screen. This will match the signal amplitude to use most of the digitizer's range, allowing the most bits to be used.

Volts/division can be set via the V/div Combo to Settings.

Volts/Division Probe can be set to

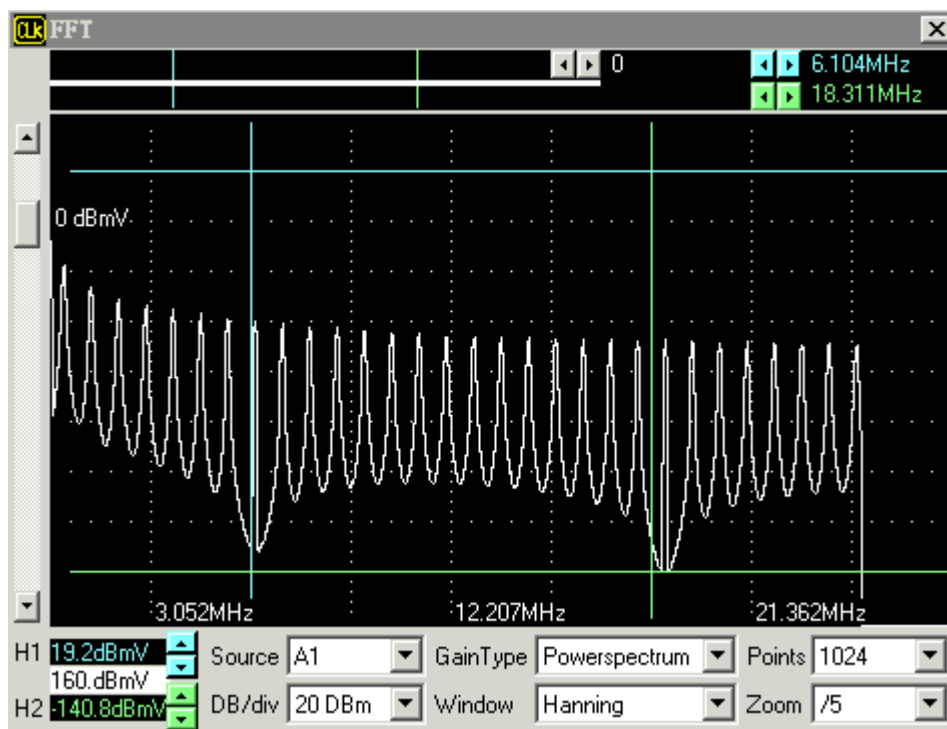
5mV, 10mV, 20mV, 50mV, 100mV, 200mV, 500mV, 1V, 2V (1:1)
 50mV, 100mV, 200mV, 500mV, 1V, 2V, 5V, 10V, 20V (10:1)
 500mV, 1V, 2V, 5V, 10V, 20V, 50V, 100V, 200V (100:1)
 5V, 10V, 20V, 50V, 100V, 200V, 500V, 1000V, 2000V (1000:1)

Offset

This parameter offsets the input signal in relation to the digitizer. This changes the usable input voltage range. The input voltage range is the offset ± 5 divisions. Thus if you moved the offset to 1.00V with 1V /division the usable range would be 6.00V to -4.00V. Data outside the input range is clipped and stored as either the max or min input value. The offset references the 0.00V point (GND) for the input channel.

The ground point is marked on the screen by the Ground Point Tick Marks to the right of the Analog Display. To change the offset in this dialog box, move the elevator button in the scroll bar. The offset can also be changed by grabbing and moving the appropriate Ground Point Tick Mark in the analog display area.

FFT (Window Menu)



The FFT window allows control and display of FFT's.

The following controls are available:

Window Select the FFT window type: (Triangular, Hanning, Hamming, Blackman-Harris, Rectangular, Wetch and Parzen).

Sample points Select how many points the FFT will sample, points can't exceed memory depth.

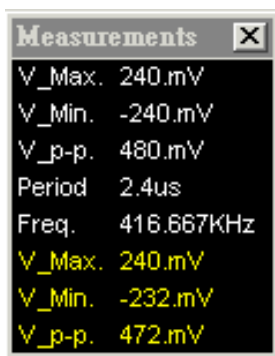
Horizontal zoom Select horizontal zoom ratio.

The FFT routines will process the selected channel starting at V1Bar and continue until "Sample Points" number of points has been reached. If V1Bar is not within the buffer, start of buffer will be used.

Further information on FFT's can be found in the following sources:

Embedded Systems Programming magazine Volume 3, Number 5, May 1990
 Embedded Systems Programming magazine Volume 7, Number 9, Sept 1994
 Embedded Systems Programming magazine Volume 7, Number 10, Oct 1994
 Embedded Systems Programming magazine Volume 8, Number 1, Jan 1995
 Embedded Systems Programming magazine Volume 8, Number 2, Feb 1995
 Embedded Systems Programming magazine Volume 8, Number 5, May 1995
 Circuit Cellar Ink, The Computer Applications Journal Issue 52 Nov 1994
 Circuit Cellar Ink, The Computer Applications Journal Issue 61 Aug 1995
 Dr. Dobb's Journal Issue 227 Feb 1995

Measurements (Window menu)



Automatic measurements on input waveforms can be performed. These include frequency, period, rise time, fall time, min, max, area,

Pulse parameter measurements are performed as specified by ANSI/IEEE std 181-1977 IEEE Standard on Pulse Measurement and Analysis by Objective Techniques.

Up to 10 signal parameters can be measured, tested, and displayed simultaneously. To setup a measurement, select the **Measurements (Setup menu)** and choose one of the tests to setup (1 to 10)....

Parameter Measurements

area Sum of all voltages * sample time.

V1Bar (time) Position of V1Bar in time.

V2Bar (time) Position of V2Bar in time.

H1Bar (voltage) Position of H1Bar in voltage.

H2Bar (voltage) Position of H2Bar in voltage.

trigger cursor Position of trigger cursor in time.

V1-V2 (time) Time difference between V1Bar and V2Bar.

H1-H2 (voltage) Voltage difference between H1Bar and H2Bar.

V1-trigger (time) Time difference between V1Bar and trigger cursor.

V2-trigger (time) Time difference between V2Bar and trigger cursor.

V_max. Maximum voltage.

V_min. Minimum voltage.

V_p-p. The difference between maximum and minimum voltages.

V_Avg. Average of minimum and maximum voltages.

rms SQRT $\left(\left(\frac{1}{\# \text{ samples}} \right) * \left(\sum \left((\text{each voltage}) * (\text{each voltage}) \right) \right) \right)$

rms (AC) $\text{SQRT} \left(\left(\frac{1}{\# \text{ samples}} \right) * \left(\sum \left((\text{each voltage} - \text{mean}) * (\text{each voltage} - \text{mean}) \right) \right) \right)$

Period Average time for a full cycle for all full cycles in range.

Duty cycle (rising) A ratio of width (rising) to period. starting with a positive edge using midpoint.

Duty cycle (falling) A ratio of width (falling) to period. starting with a negative edge using midpoint.

Risetime(10..90) Average time for a rising transition between the 10% to the 90% points.

Risetime(20..80) Average time for a rising transition between the 20% to the 80% points.

Falltime(10..90) Average time for a falling transition between the 10% to the 90% points.

Falltime(20..80) Average time for a falling transition between the 20% to the 80% points.

Pulse width (positive) Average width of positive pulses measured at 50% level.

Pulse width (negative) Average width of negative pulses measured at 50% level.

Frequency Average frequency of waveform.

Accessories

Test Probe, Clips and Wires:

Extra Test Probe (x1, x10), clips and wires are available.

Dynamic Link Library [DLL]:

It is optional to order. Software libraries are available to allow the user to write custom programs to control the instruments.

Windows 98/ME USB driver install

When USB (ver 1.1/2.0) cable be connected to computer, screen will display as following:



Click Next to continue



Edit or browse path to ...\\USB20driver\\win98_ME\\gene.inf
(here D: is CD location, dso25216A may be dso29xx)

Click Next to continue



Click Next to continue



Completing install

Windows 2000 USB driver install

When USB (ver 1.1/2.0) cable be connected to computer, screen will display as following:



Click Next to continue



Click Next to continue



Click Next to continue



Edit or browse path to ...\\USB20driver\\win2000_XP\\gene.inf
(here F: is CD location, dso25216A may be dso29xx)
Press OK



Click Next to continue



Click Yes to continue



Completing install

Windows XP USB driver install

When USB (ver 1.1/2.0) cable be connected to computer, screen will display as following:



Click Next to continue



Edit or browse path to ...\\USB20driver\\win2000_XP\\gene.inf

(here E: is CD location, dso25216A may be dso29xx)

Click Next to continue



Press Continue Anyway



Completing install

Technical Support

Technical support can be reached at



10 Electro Road, Toronto, ON, M1R 2A7, Canada

Phone: +1 (416) 7570764

Fax: +1 (416) 7570764

E-mail: Support@rorixwell.com

Software Updates

Software can be downloaded from our website

<http://www.Rorixwell.com>



10 Electro Road, Toronto, ON, M1R 2A7, Canada

Phone: +1 (416) 7570764

Fax: +1 (416) 7570764

E-mail: Support@rorixwell.com

APPENDIX

Fast Fourier Transformations

Understanding FFT's Application

Introduction to FFT

Detecting and measurement are the basic functions of signal processing. In some application, it is important to analyze the periodic components of sinusoidal signals. FFT can serve as a tool to dismember a signal into its periodic components for analysis purposes.

Typical FFT of Applications

- 1) Antenna's directional diagram is a function of Fourier's Transformation of transmitting current.
- 2) On the front and back focus planes of convex lens in an optical system, the amplitude distribution is a Fourier's Transformation.
- 3) In Probability, a power density spectrum is a Fourier's Transformation.
- 4) In Quantum Theory, the Momentum and Location of a particle are connected through Fourier' Transformation.
- 5) In Linear System, Fourier Transformation is the product of System Transmission Function times Input Signal Fourier Transformation.
- 6) The Noise Analysis of signal detecting can be obtained through Fourier Transformation. These are all different applications, but they share the same analytical path which is Fourier Transformation.

Fundamental Principles

The Fourier Transformation Formula:

$$F(x) = (1/M) \sum_{K=0}^{2M-1} T_k \{ \cos [2\pi K(x/M)] + i \sin [2\pi K(x/M)] \}$$

T_k : The mapping data value for the Time Domain.

$F(x)$: The mapping data value for the Frequency Domain.

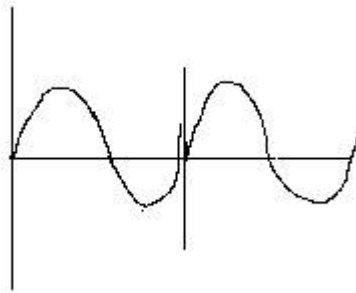
M : FFT data length.

X : The mapping data value for the Frequency Domain.

i : Imaginary number.

The result of the formula is a vector of complex number. To show this on the screen, we present the Frequency as horizontal coordinate, we make the leftmost position representing zero frequency that is the direct current component. Harris had pointed out that due to periodic characteristics of FFT, we could observe the phenomena of discontinuation at the boundaries of a finite length sequence. Therefore when we select randomly a signal sample, we could see points of discontinuation as a result of periodic expansion. This would produce

leakage of Frequency Spectrum across the whole frequency band. To suppress the amplitude of sample around the boundaries, we must apply Weight Function to it.



discontinuation

The Vertical Axis on the screen is expressed in terms of Magnitude, Decibel (db) and Logarithm.

Magnitude

$$Mn = \sqrt{Rn^2 + In^2}$$

Decibel (db)

$$\begin{aligned} \text{dbm Ps} &= 10 \log (Mn^2 / Mref^2) \\ &= 20 \log (Mn / Mref) \end{aligned}$$

Here Mref represents the reference value. It is define as 0 dbm or 0.316 V Peak-to-Peak Value or Effective Value 0.244V. It is define as 1.0 mW or it is defined as Resistance Value 50 Ω .

Logarithm

In this mode, the display is expressed in decibel and the Measurement is expressed in Magnitude.

Generally speaking, the Spectrum Processing System is expressed in the following formula:

$$Y(k) = \sum_{n=0}^{N-1} A(n) * X(k-n)$$

This formula utilizes Weighting function that is also known as Window. For example, Hanning, Hamming, Blackman, Triangle and Rectangle. These are further explained as following:

Hanning: It is $\cos \alpha (\theta)$ type window, expressed mathematically as following:

$$a(n) = 0.5 [1 - \cos (2 \pi n / N)]$$

Hamming: It is similar to Hanning. The only difference is the coefficients for cosine term.

$$a(n) = 0.54 - 0.46 \cos (2 \pi n / N) , n = 0, 1, 2, \dots, N-1$$

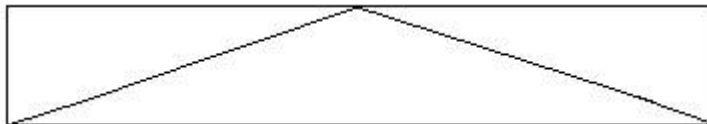
Blackman: It is the sum of a series of cosine terms. It is equal to Weighting function.

$$a(n) = \sum_{m=0}^M (-1)^m b(m) \cos (2 \pi n m / N) , n = 0, 1, 2, \dots, N-1$$

Triangle: Triangle Weighting Function, It is define as following:

$$a(n) = \begin{cases} 2n/N & n=0,1,2,\dots, N/2 \\ a(N-n) & n=(N/2)+1,\dots, N-1 \end{cases}$$

Rectangle: Rectangle Weighting Function



window coefficients



FFT. of window
Triangle Weighting Function

The Characteristics of Weight Function

Window	Highest Side Lobe	3db Bandwidth (bins)	5db Bandwidth (bins)	Scallop Loss (db)
Hanning	-35	1.54	2.14	1.26
Hamming	-43	1.30	1.81	1.78
Blackman	-61	1.56	2.19	1.27
Triangle	-27	1.28	1.78	1.82
Rectangle	-13	0.89	1.21	3.92

Functionality

The functionality of FFT can be achieved through the use of Utility. To use the Utility, We must set Channel/Math first, and then turn on FFT or Bw.sweep. We have to Bear that in mind that we could only analyze one channel at a time. After finish all the settings, we could see the screen showing FFT Channel.

We describe the differences between FFT and Bw,sweep as follow:

FFT

If we are using this mode, we are analyzing Channel A1 or Channel A2 in an Real Time Mode. To achieve the state of Synchronized Display. We are measuring time Domain while we are displaying Fourier Frequency Domain. In addition to that, we are able to analyze the stored signal easily. We only need to read the file on A1 Channel or A2 Channel, and then thrown on FFT. Whether we turn on Go or not is the difference in retrieving signals.

Bw.Sweep

When turning on this mode, we are analyzing A1 Channel or A2 Channel through the Frequency Sweep Mode to achieve the State of Frequency Output. The user must apply additional frequency to the point of measurement. Also we have to increase the frequency from small to large gradually. The finer the increment of frequency, the better the obtained data will be. Attention must be made to clear the Frequency and record Sweep Frequency again every time when we turn on Go to retrieve signal.

When a user set the Mode, he can also set the FFT parameters.
These are the required settings and they are explained as following:

Source

From channel A1, A2, M1 or M2.

Points

The points to be used are 256, 512, 1024, 2048, 4096, 8192, 16384 and 33678.
The user could think of these points as the scope of period. It can be understood that the more points we are taking, the better the results will be except the speed of it would be sacrificed. This is because the more you analyze the more time it takes to get the job done. It is an user's responsibility to make a judgment as to how a compromise should be achieved.

Window

The window is also known as (Weighting function), it includes Hanning (a fixed value, generally is peaking), Hamming, Blackman, Triangle and Rectangle. Please refer to the Fundamental Principle of this article. Due to periodic characteristics of FFT, we observe the discontinuation phenomena around the boundaries of the finite length sequence. We must use Window to suppress the amplitude of the sample around the boundaries.

Gain Type

The Vertical Axis on the screen is expressed in terms of magnitude, Power Spectrum and Logarithm.

- 1. Magnitude:** The magnitude of the Polar Coordinates on the screen.
- 2. Logarithm:** in this mode, it display Power spectrum and the measurement is expressed as Magnitude.
- 3. Power Spectrum:** By formula $P_s = 20 \log (M_n/M_{ref})$.
Here M_{ref} represents the Reference Value of 0.316V.
It is defined as 0 dbm.
0.316V p-p or 0.244V Effective Value also known as 1.0mW and the Resistance of 50 Ω .

The Vertical Axis on the screen is expressed in terms of Magnitude, db or Logarithm. These are explained as following:

- DB/div:** It is active only when Gain Type is set to Power spectrum. It is the unit of the Vertical coordinate. It represents DBm.
There are four different scales: 5, 10, 20, 50 DBm.
- DB/offset:** It is active only when Gain Type is set to Power spectrum. It can change the position of FFT to make it going up and down.

To obtain the measured data, using Ctrl and Alt keys plus Left or Right key to measure Frequency. To measure Magnitude, we can use Ctrl or Alt key plus Up or Down key. After that we can get the data displayed in the rectangle frame of FFT parameter.

Notes:

It is highly desirable to confirm the following items before doing analyzing:

- 1) If the measurement is for low frequency, we ought to make sure the frequency of the sample is not too large. Since the larger the frequency of the sample the large the Band Width. The sample frequency needs to be as twice as large as the frequency to be measured.
- 2) It is undersirable to use Logic Analyzer and FFT simultaneously.
- 3) It is desireable to have waveform on the Time Domain. The stronger the waveform the better the accuracy of the results.
- 4) To obtain the highest speed on FFT, we could turn all the channels off except for FFT.
- 5) The values of Depth can be 4K, 64K. When using 4K, we are using the real part and Imaginary part of the integer results of the Simulator Output for independent Probability Noise Signal. The MSE calculation results is obtained using 16 bits FFT processor with db less than 75 DB. If using db value greater than 75 DB, we are going to get too great an inaccuracy. When we are using 64K Depth, we are doing floating point calculation therefore the machine we use must have floating point math coprocessor.